

FIG. 1

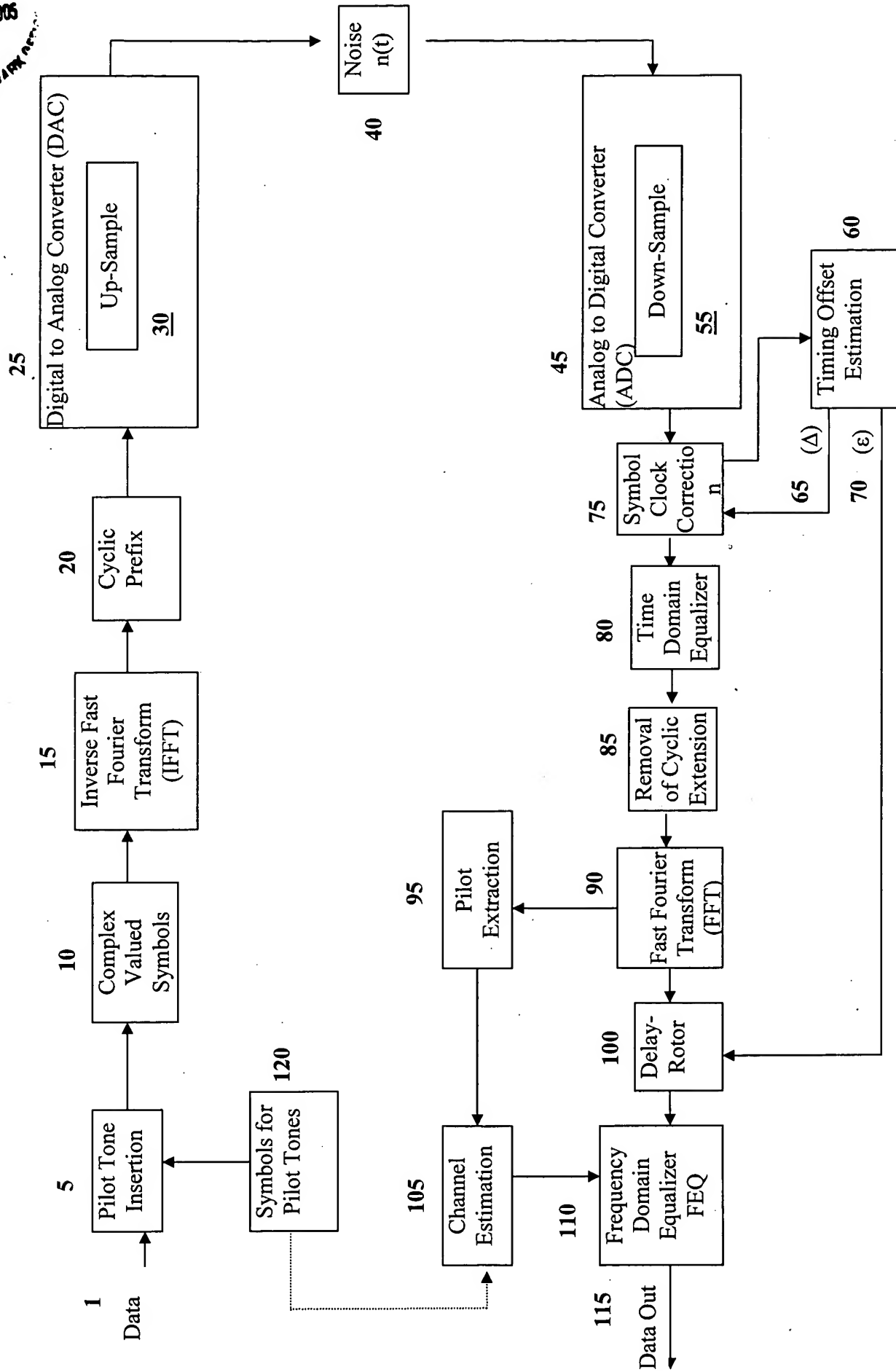


FIG. 2



$$x_n = \sqrt{N} \sum_{k=0}^{N-1} X_k e^{j \frac{2\pi k n}{N}}, n=0, \dots, N-1 \quad 2-1$$

where subscript n and k denote time index and sub-carrier index, respectively.

\underline{X}^m is generated such

$$\begin{cases} X^m_0 = X^m_N = 0 \\ X^m_k = a^m_k, k < N \\ X^m_{N+k} = (a^m_{N-k})^* \end{cases} \quad 2-2$$

$$x^m_{-k} = x^m_{N-k} \quad 2-3$$

If the Channel Impulse Response (CIR) is denoted by vector $\underline{h} = [h_0, \dots, h_{N_c-1}]$, then the received signal can be written as

$$y_n = h_n x_n + n_n \quad 2-4$$

where n_n is the noise sample at n -th time instant.

$$Y_k = \frac{1}{\sqrt{N}} \sum_{n=0}^{N-1} x_n e^{-j \frac{2\pi k n}{N}}, k=0, \dots, N-1 \quad 2-5$$

$$Y^m_k = H_k X^m_k + N^m_k, k=0, \dots, N-1 \quad 2-6$$

Here, uppercase letters represent FFT of the corresponding time-domain signals.

FIG. 3

$$R(\hat{D}) = \sum_{n=0}^{LP-1} r(n + \hat{D}) r(n + N + \hat{D}); \quad \hat{D} = 0, 1, \dots, \hat{D}_{\max} \quad 3-1$$

where $r(n)$ is the received signal sample at n -th instant, \hat{D}_{\max} is the maximum possible delay. From the correlation function values for various delays, \hat{D} is selected where the function has the maximum value.

$$\{i, \quad i + N/L \quad \dots \quad i + N - N/L\}, i = 0, 1, \dots, N/L - 1. \quad 3-2$$

$$R^m_k = H_k + \frac{V^m_k}{|X^m_k|}, k = 0, \dots, N - 1 \quad 3-3$$

$$\text{where } R^m_k = \frac{Y^m_k}{X^m_k} \text{ and } V^m_k = \frac{N^m_k}{e^{j\angle X^m_k}}$$

Where vectors $\hat{\underline{h}} = [h_0 \quad h_1 \quad \dots \quad h_{L-1}]$ and

$\underline{R}_{pl} = [R_i \quad R_{i+N/L} \quad \dots \quad R_{i+N-N/L}]$, and the matrix \underline{Q}_{pl} is defined as:

$$\underline{Q}_{pl} = \frac{1}{\sqrt{N}} \begin{bmatrix} 1 & W_N^i & \dots & W_N^{i(L-1)} \\ 1 & W_N^{(i+N/L)} & \dots & W_N^{(i+N/L)(L-1)} \\ \dots & \dots & \dots & \dots \\ 1 & W_N^{(i+N-N/L)} & \dots & W_N^{(i+N-N/L)(L-1)} \end{bmatrix} \quad 3-4$$

$$\text{where } W_N = e^{-j\frac{2\pi}{N}}.$$



FIG. 4

$$MSE_{normalized} = \frac{E\|\hat{h} - h\|^2}{E\|h\|^2} \quad 4-1$$

where \underline{h} is the actual channel and $\hat{\underline{h}}$ is the MMSE estimation

$$C_k = \frac{1}{H_k}, \quad k = 0, 1, \dots, N-1 \quad 4-2$$

$$C_k = \frac{H_k^*}{|H_k|^2 + \sigma_n^2 / \sigma_a^2} \quad 4-3$$

FIG. 5

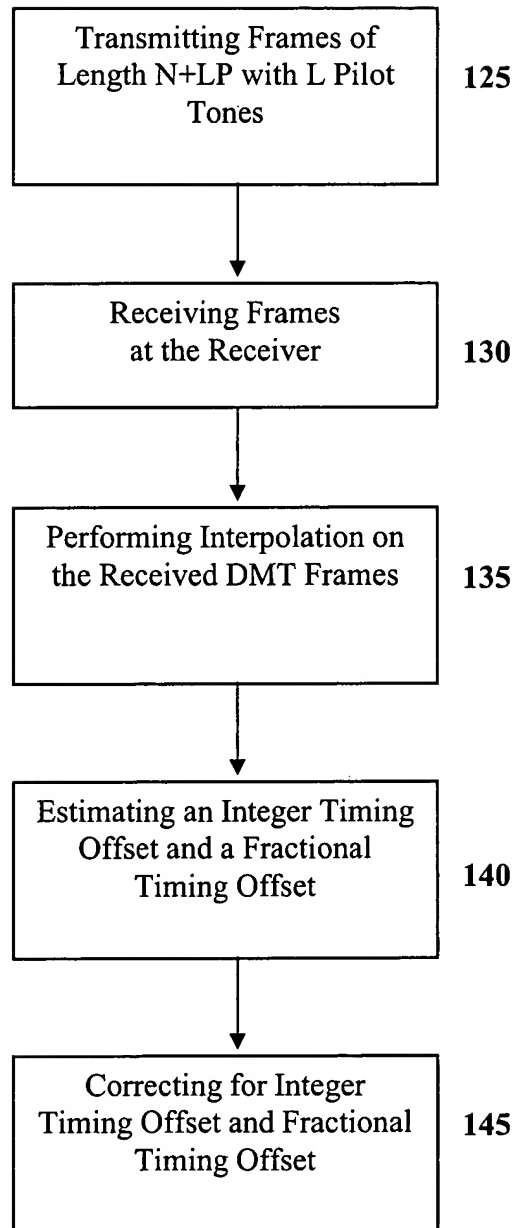


FIG. 6

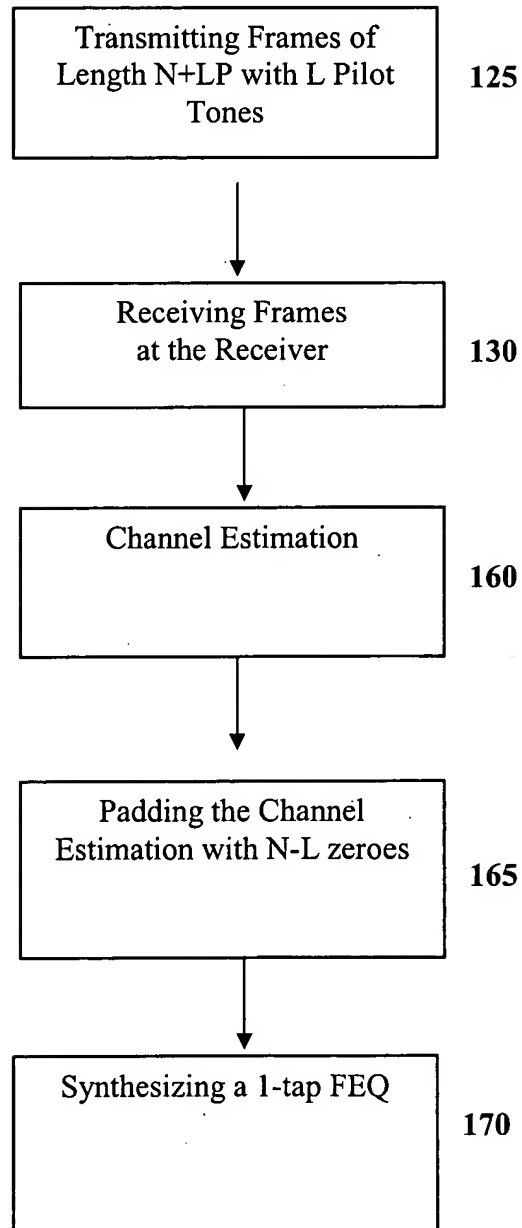


FIG. 7

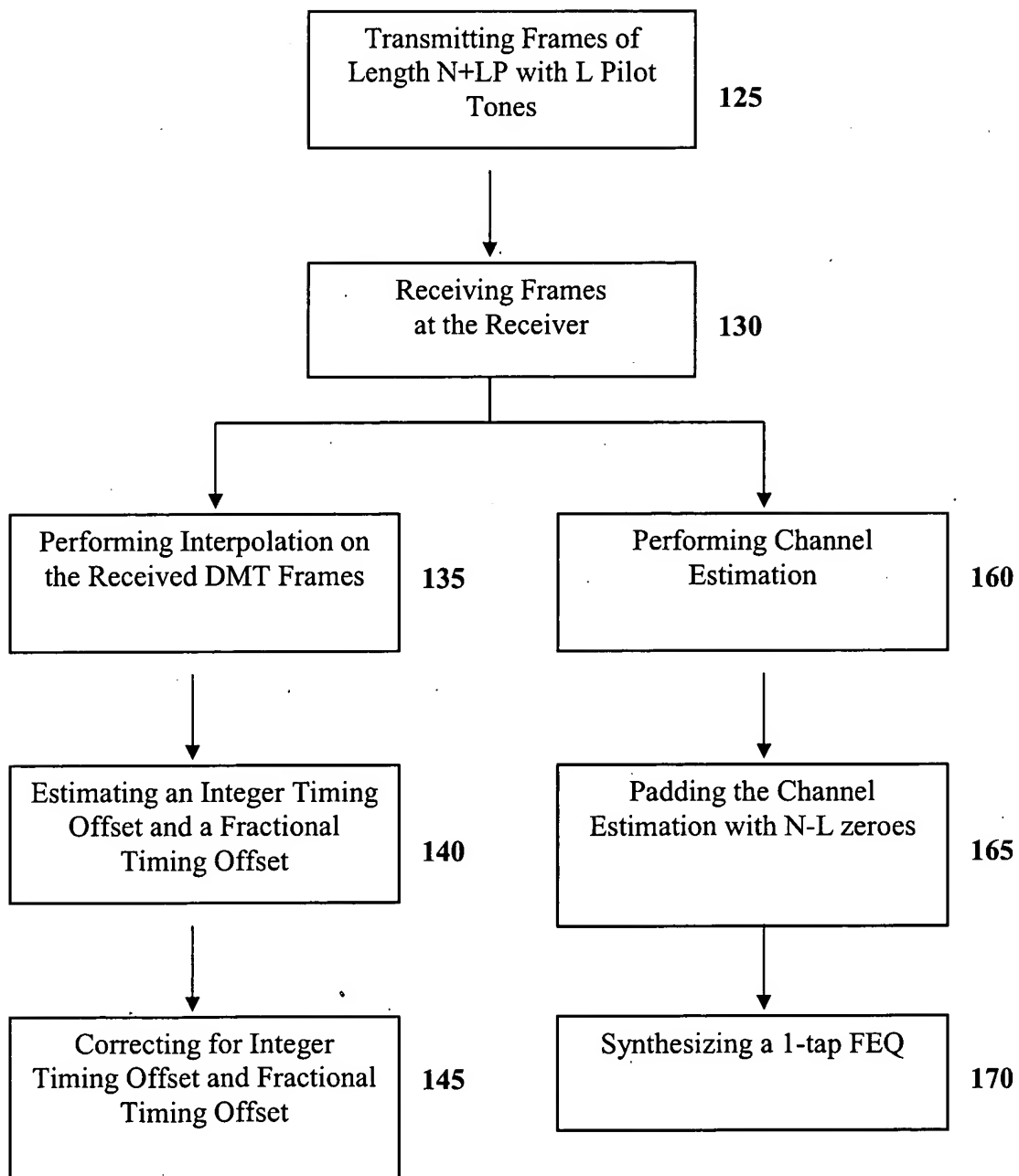


FIG. 8

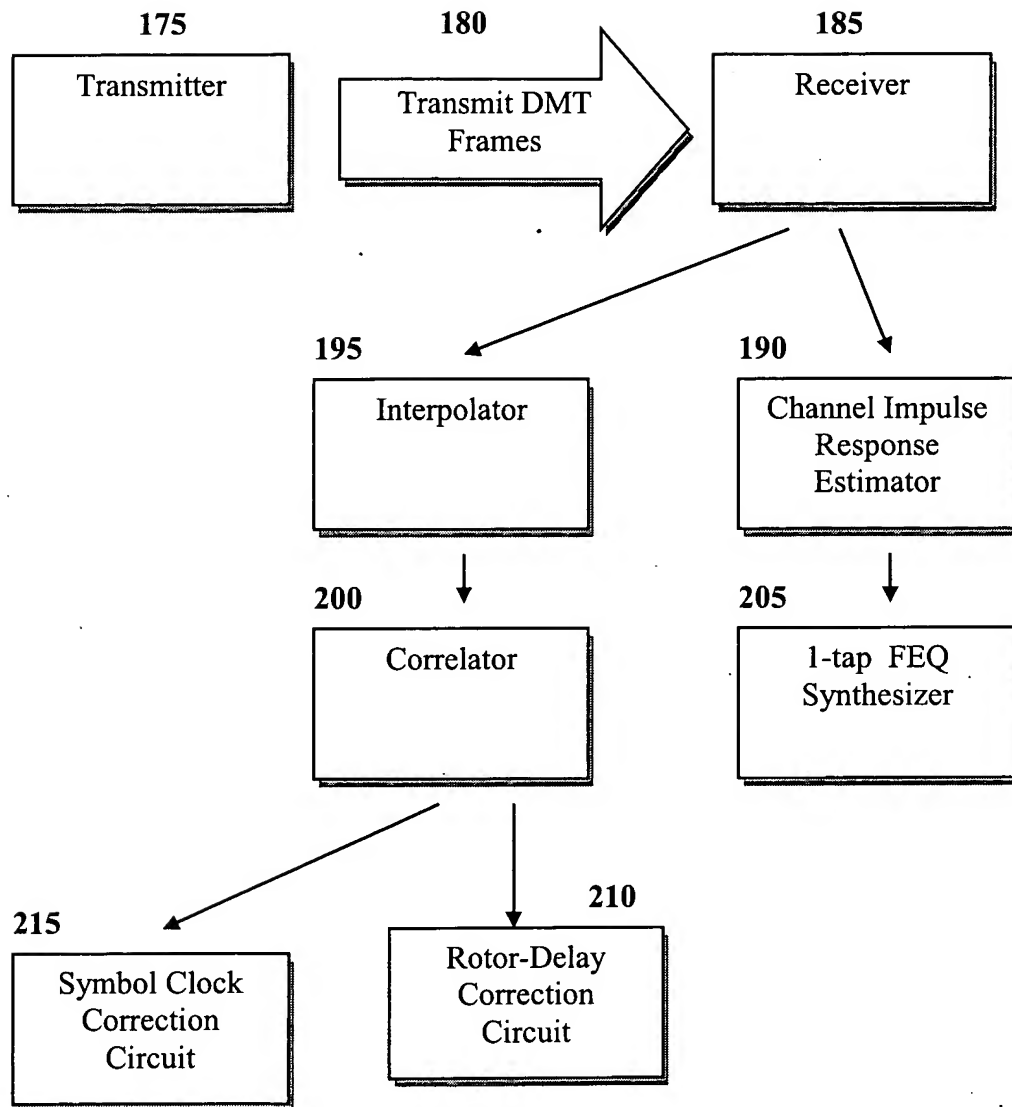


FIG. 9

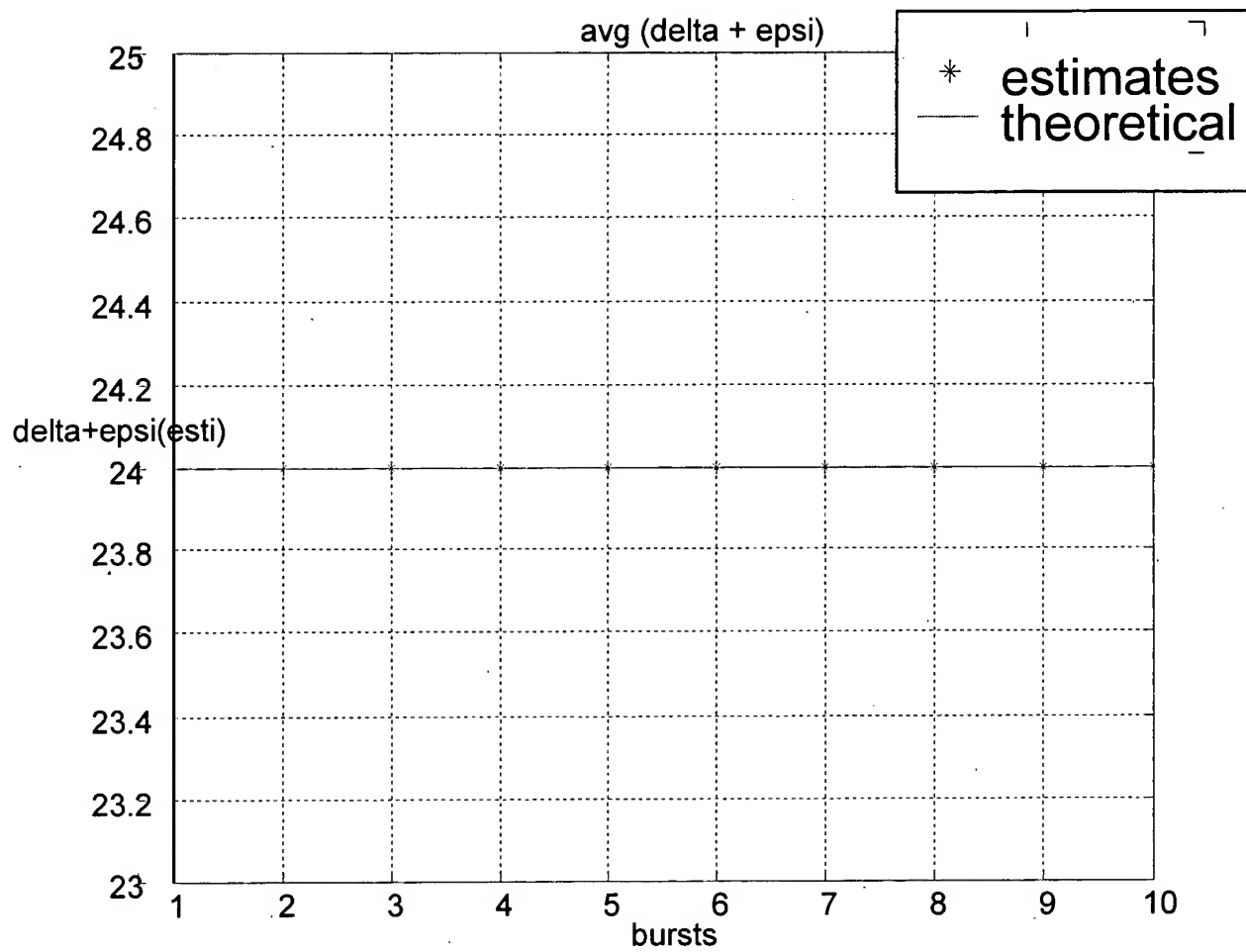
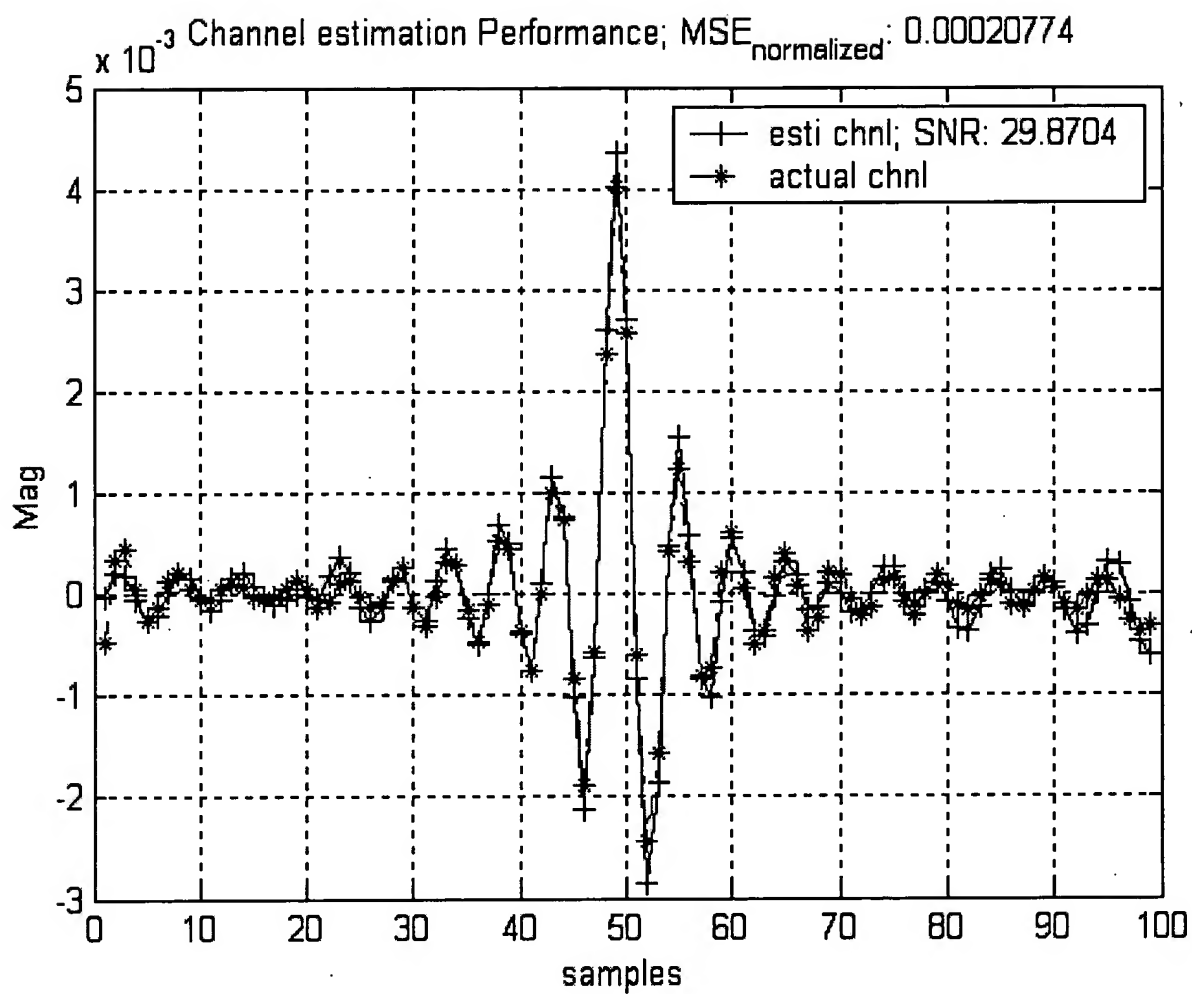


FIG. 10



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FIG. 11

